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Characteristics of Sandy-Clay Mixed With Various Proportions of Sugarcane Fiber

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***Abstract*— In many situations, the engineers in road construction face the problem of subgrade soil of loose and soft soil with poor drainage conditions resulting low CBR value when placed at OMC in compacted condition. Huge amount of sub-grade soil is being required for constructing of large amount of road construction. But available strength of soils near road construction sites is not suitable. Such soils need addition of some strengthening elements. Natural fibers from sugarcane are biodegradable, eco-friendly and are available in high amount in many countries at very low cost. The mixing of fibre in soil results increase in strength and decrease of deformability. In this investigation, Sugarcane fibre was randomly mixed at varying length and percentage with weak clayey soil to improve the compactness and strength of soil. A series of standard Proctor test and unsoaked California Bearing Ratio (C.B.R) tests were conducted for each combination of soil- fiber mix to study the compaction behaviour and changing C.B.R value of the soil- fiber mix combination. From the test results, it was observed that with the increase in percentage of fiber in soils, M.D.D decreases due to its light mass density of fibre, whereas O.M.C increases due to its high water absorption capacity. However maximum C.B.R value is achieved at mixing fibers of 2 cm length at 1% mixing by weight.**

***Index Terms*— O.M.C, M.D.D, Unsoaked C.B.R, Standard Proctor test.**

I. INTRODUCTION

Sugar cane is a seasonal agricultural crop. Sugarcane fiber is abundantly available in the many parts of India at a low cost. Brazil is the largest producer of sugar cane in the world. The plant is 2 to 6 m high belonging to tall perennial true grasses of the genus Saccharum, tribe Andropogoneae. Bagasse is the fibrous matter that remains after sugarcane stalks are crushed to extract their juice.

Now a days, large amount of construction of roads are going on in many parts of world. But available soils near construction sites are too weak for cost effective road construction. Such constructions require massive quantity of good brickbats for subbase in construction of road. But the production of bricks is being limited due to non-availability of suitable soils. So some other alternate materials are needed to use for making sub base in place of brickbats. In this context, Sugar cane natural fiber are mixed with various proportion in sandy-clay soil for increasing strength. A systematic experimental program has been undertaken for improvement of strength of sandy-clay soil, with increase in California Bearing Ratio (CBR) of such laid soil layers of the mixing these geo-natural fibers in various proportions and lengths. The present investigation highlights the efficacy of construction of sub-base with soil and Sugarcane fibers composite system, as alternate material of construction.

Maity et. al. (2012) studied the application of Sabai grass natural fiber randomly mixing with sandy soil with various proportion. The final conclusion was that the value of MDD decreases and value of OMC increases with the increase of sabai grass fiber content mixed randomly while CBR value is maximum for fiber length of 5mm for Sabai grass fibers used 1% mixing by weight.

II. PROPOSED INVESTIGATION

A. Materials Used

Sugarcane Fiber:

Natural sugarcane fiber was collected from local market and processed by cutting into small pieces of length 1cm, 2cm and 3cm for use as fiber material and is shown in Figs 1 Such cut fibers were randomly mixed in sandy-clay soil to form homogeneous mixture.

Figure 1: Natural soil

Experimental Soil:

In this present investigation, sandy- clay soils have been collected from Belda in the district of Paschim Medinipur, West Bengal, at a depth of 1.0 m below the ground surface (fig.2). The soil has been classified as CL as per IS classification and soil plasticity is low. The physical properties of this soil are given in Table-1.

Figure 2: Experimental soil

Table 1: Physical properties of soil used in the study

Properties	Values
IS Classification	CL
Specific Gravity	2.28
Liquid Limit (%)	26
Plastic Limit (%)	19.5
Consistency index	0.35
Plasticity Index (%)	6.50
Gravel (%)	0.136
Sand (%)	25.10
Coarse Sand (%)	0.95
Medium Sand (%)	6.35
Fine Sand (%)	17.80
Silt + Clay (%)	74.90
Cu	20
Cc	0.56
Maximum Dry Density (gm/cc)	1.800
Optimum Moisture Content (%)	13.8
Unsoaked CBR (%) at OMC	6.14

B. Test Programme

In this program, first sugarcane fiber are cut into various length of 1cm, 2cm & 3cm and are mixed with soil with various proportion of .5%, 1%, 1.5% & 2% by weight and were studied to investigate the effect of inclusion of fiber on compaction and unsoaked C.B.R characteristics soil. Standard Proctor tests have been conducted as per IS 2720 (Part-VII) [1] and unsoaked C.B.R tests have been conducted as per IS 2720(Part-16) at OMC of the mixed soil.

III. EXPERIMENTAL RESULTS

When Sugar cane fiber of 1cm, 2cm & 3cm length are mixed randomly with soil at different percentage of 0.5%, 1%, 1.5 % & 2%, the value of M.D.D, O.M.C & C.B.R obtained from standard Proctor and CBR test are given in Table-2.

Table 2: Summary of Test result

Description of mix	length (cm)	MDD (gm/cc)	OMC (%)	Unsoaked CBR
Soil without fiber	-	1.800	14	6.14
Soil +.5% fiber	1cm	1.762	14.40	7.69
Soil +1% fiber		1.712	15.40	7.97
Soil +1.5%fiber		1.662	15.60	7.36
Soil +2% fiber		1.661	16.40	7.40
Soil +.5% fiber	2cm	1.77	15.60	7.40
Soil +1% fiber		1.750	15.80	8.01
Soil +1.5% fiber		1.734	15.90	7.53
Soil +2% fiber		1.720	16.00	6.95
Soil +.5% fiber	3cm	1.764	15.40	7.65
Soil +1% fiber		1.742	15.90	7.9
Soil +1.5% fiber		1.728	16.10	7.45
Soil +2% fiber		1.714	16.30	7.00

Variation of MDD with % of fiber of different length

The variation in MDD vs % Fiber content curve are plotted with varying length of fibers are shown in Fig. 3.

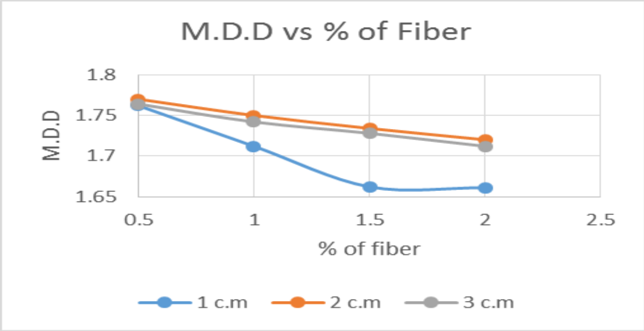

Figure 3: M.D.D vs % of fiber with varying length

The result shows that as the fiber content increases, the maximum dry density decreases for sandy-clay soil.

Variation of O.M.C with % of fiber of different length

The different values of optimum moisture content for mixing fiber are shown in table 2. The variation in O.M.C vs % Fiber content curve are plotted with varying length are shown in Fig.4.

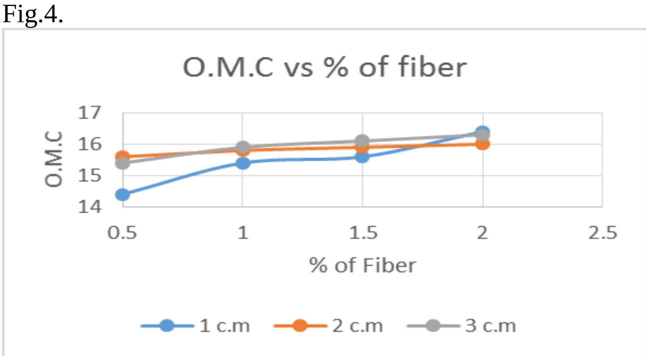

Figure 4: O.M.C vs percentage of fiber with varying length

Result shows that as the fiber content increases, the optimum moisture content increases for sandy-clay soil gradually.

Variation of unsoaked C.B.R with percentage of fiber

The different values of C.B.R for fiber mixed soils are shown in table 2. The variation in C.B.R vs percentage of Fiber curves are plotted with varying length are shown in Fig .5.

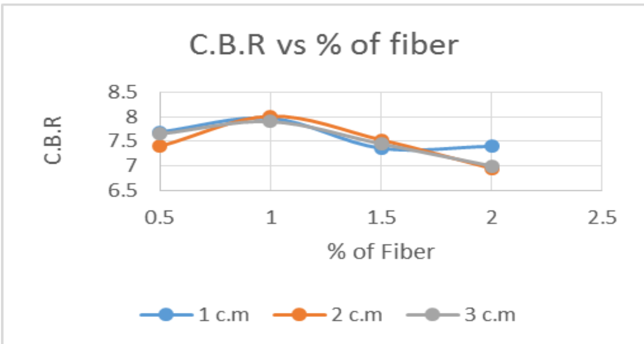

Figure-5 Unsoaked C.B.R vs percentage of fiber

Result shows that highest unsoaked C.B.R value is achieved for 1% of fiber being mixed. After that with increasing the fibre, C.B.R value decreased. Maximum unsoaked C.B.R value is achieved as 8.1 when 2 cm fiber is mixed at 1% by weight.

IV. REGRESSION ANALYSIS

Regression analysis is a statistical technique for modeling the relationship between two or more variables. A number of techniques can be used to indicate the adequacy of a linear regression model. One of these technique for linear regression may be carried out with R-squared values. During regression analysis, a regression model with higher R-squared value (with R^2 value ranging from 0.978 to 0.987) is usually accepted.

A. Effect of fibers on Max. Dry Density,
For 1 cm fiber,
M.D.D= .049 (% of fiber) ^{2}-.1931 (% of fiber) +1.848…. (1)
For 2 cm fiber,
M.D.D= .006 (% of fiber) ^{2}-0.0482 (% of fiber) +1.79......(2)
For 3 cm fiber,
M.D.D= .006 (% of fiber) ^{2}-.049 (% of fiber) +1.7865…..(3)

B. Effect of fibers on Optimum moisture content,
For 1 cm fiber,
O.M.C= -0.2 (% of fiber) ^{2}+1.74 (% of fiber) +13.65…....(4)
For 2 cm fiber,
O.M.C= -0.1 (% of fiber) ^{2}+0.51 (% of fiber) +15.375.......(5)
For 3 cm fiber,
O.M.C= -0.3 (% of fiber) ^{2}+1.33 (% of fiber) +14.825…..(6)

C. Effect of fibers on California Bearing Ratio Test
For 1 cm fiber,
C.B.R= -0.24 (% of fiber) ^{2}+.304 (% of fiber) +7.65……..(7)
For 2 cm fiber,
C.B.R= -1.19 (% of fiber) ^{2}+2.609 (% of fiber) +6.4425…(8)
For 3 cm fiber,
C.B.R= -0.7 (% of fiber) ^{2}+1.27 (% of fiber) +7.225……..(9)

V. CONCLUSION

Based on the experiments carried out on soil and soil fiber composite, the following observations and conclusions are drawn:

1) Optimum moisture content increases with increasing of % of fiber due to its high water absorption capacity.
2) Max dry density decreases with increasing of percentage of fiber due to its low mass density.
3) The result shows that highest unsoaked C.B.R value is achieved for 1% of mixing fiber and after that with increasing the percentage of fiber, C.B.R value decreases. Maximum unsoaked CBR value is 8.1 by mixing 2 cm long fiber at 1% by weight.
4) The multiple linear regression equations are generated to predict Optimum Moisture Content (OMC), Max Dry Density (M.D.D) & C.B.R value in percentage (%) with certain Fiber content for various lengths.

REFERENCES

[1] IS: 2720 (Part VII) – 1987, Methods of tests for soil : Determination of water content- dry density relation using light compaction, *Bureau of Indian Standards*, New Delhi.
[2] IS: 2720 (Part XVI) – 1987, Methods of tests for soil: Determination of C.B.R, *Bureau of Indian Standards*, New Delhi.
[3] MaityJ, Chattopadhyay, B,C&Mukherjee,S., P (2012), "application of fibres from sabai grass in construction of subbase of roads in conjunction with sands" December, 13 to 15, 2012, Bangkok, Thailand.
[4] R.PAbhijith (2015), " Effect of natural coir fibres on CBR strength of soil" . International Journal of Scientific and Research Publications, vol-1, 2015.

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